Leaf Area Index Change Detection of Understory Vegetation in the Albemarle-Pamlico Basin Using IKONOS and Landsat ETM+ Satellite Data

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The advent of remotely sensed data from satellite platforms has enabled the research community to examine vegetative spatial distributions over regional and global scales. This assessment of ecosystem conditions through the synoptic monitoring of terrestrial vegetation extent, biomass, and seasonal dynamics has begun to answer questions related to carbon sequestration and the expansion of greenhouse gases, biogenic emissions, and the inputs into air quality and other significant environmental issues. Validation of these satellite-derived vegetative parameters includes the examination of accumulated variances stemming from data acquisition, to data processing, and to final accuracy assessment. The importance of understanding variation through the entire process involves the significance of these inputs into process-based models. One input of interest, leaf area index (LAI), defined here as one-half the total green leaf area per unit ground surface area, has been used for the quantification of surface photosynthesis, evapotranspiration, and annual net primary production used in the calculation of terrestrial energy, carbon, water cycle processes, and biogeochemistry of vegetation.

The significance of LAI as source data for process-based ecological models has been well documented. Running and Coughlan (1988) ranked LAI as the most important attribute of vegetation structure for characterizing forest canopies over large areas at broad spatial scales using satellite remote sensing data. Most ecosystem process models that simulate carbon and hydrogen cycles require LAI as an input variable. By controlling terrestrial mass and energy fluxes, vegetation plays a vital role in global climate change. Interest in tracking LAI change includes the role that forests play in the sequestration of carbon from carbon emissions (Johnsen et al., 2001) and the formation of tropospheric ozone from biogenic emissions of volatile organic compounds (BVOC) naturally released into the atmosphere (Geron et al., 1994).

The confounding effect of understory vegetation contributions to satellite-derived estimates of LAI was investigated on two loblolly pine (*Pinus taeda*) forest stands located in the southeastern United States. Previous studies have shown that understory can account from 0-40% of the total LAI values, thus influencing the near infrared (NIR) and visible (VI) spectral response. Two 1.0-ha study plots of planted loblolly pine stands (ages 19 and 23) with similar crown closure estimates (70% and 71%, respectively) were studied for spectral response before and after a complete mechanical harvest and herbicide application in late July and early August 2002. IKONOS and Landsat ETM+ data were collected both prior and subsequent to understory removal and were evaluated for NIR and VI wavelength response. Study results will assist in the validation of 1-km LAI satellite product derived from the Moderate Resolution Imaging Spectrometer (MODIS) sensor. The Atmospheric Modeling Division within ORD is currently evaluating this 1-km data for potential input into a number of air quality models.

Literature Citations

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